Nahid Zoueshtiagh/R9/USEPA/US

03/08/2006 11:17 AM

To: Joseph Lapka/R9/USEPA/US@EPA

cc:

bcc:

Subject: old item -- Cabrillo Port Project: Air Quality Modeling Protocol

Nahid Zoueshtiagh

----- Forwarded by Nahid Zoueshtiagh/R9/USEPA/US on 10/28/2003 01:04 PM -----

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10/23/2003 07:41 PM

To: Carol Bohnenkamp/R9/USEPA/US@EPA
cc: Nahid Zoueshtiagh/R9/USEPA/US@EPA, TUmenhofer@entrix.com
Subject: Cabrillo Port Project: Air Quality Modeling Protocol

Carol:

Per our previous conversations with you and other members of the EPA Region IX Air Permitting group, please find attached a copy of the draft modeling protocol for the referenced project. Please note that we have included the following in this draft document:

- Rationale for the selection of the onshore and offshore meteorological data sets;
- Discussion of the methodology used for the execution of the OCD model for this project application,
- QA/QC of the air quality impact analysis (AQIA); and
- Summary of the results of the AQIA.

Should you have any questions concerning this draft document, please contact me.

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Modeling Protocol.doc

6.0 AIR QUALITY IMPACT ANALYSIS

DRAFT

6.1 AIR QUALITY MODELING METHODOLOGY

6.1.1 Model Selection

The air quality impacts of the proposed Project criteria pollutants were estimated through the use of the USEPA-approved Offshore and Coastal Dispersion (OCD) Model. This model is an extension of the classical gaussian plume model, specifically designed to simulate the effects of offshore emissions from point, area, or line sources on the air quality of coastal regions. The model includes special algorithms that account for over-water plume transport and dispersion, as well as changes that take place as the plume crosses the shoreline. The OCD model accounts for offshore downwash, to evaluate the partial penetration of the plume when a temperature inversion is present, and to compute fumigation episodes. It assumes short distances and short time intervals. The OCD model requires a combined data set to complete an over-water analysis, meaning it combines offshore meteorological data with onshore stability class and temperature data.

6.1.2 Onshore Meteorological Data

In this case, the onshore stability class and temperature data came from the Ventura-Emma Wood State Beach monitoring station for the years 1991-1993. The Emma Wood State Beach monitoring station is located off US Route 101, two miles north of Ventura, CA. (longitude-119:18:15, latitude-34:16:50). The VCAPCD provided pre-processed, quality controlled meteorological data sets for this dispersion modeling application. The 1991-1993 data was the only pre-processed, quality controlled data available from the VCAPCD to demonstrate onshore impacts to Ventura County. The VCAPCD provides data in this quality controlled format for the years 1991-1993 for applicants to perform health risk assessments. The VCAPCD requires an air quality data recovery rate of 90 percent for all possible hours for an acceptable monitoring year of data. The 1991-1993 data set meets these requirements. Furthermore, the Emma Wood State Beach monitoring station is the closest meteorological monitoring station to the Project with multiple years of pre-processed data. Therefore, the VCAPCD 1991-1993 onshore data set was selected as the most recent and appropriate onshore data to perform the OCD modeling analysis for this Project.

The Emma Wood monitoring station data obtained from the VCAPCD was imported and parsed into an EXCEL spreadsheet in a Storage and Retrieval of Aerometric Data (SAROAD) format in order to facilitate the input of the data into the OCD model. An algorithm used in EPA-approved pre-processor programs to prepare meteorological data for EPA air models was utilized to determine stability class overland (Pasquill stability categories). This algorithm may be utilized when data for sigma theta (standard deviation of horizontal wind direction variation) is available. The algorithm is a two-tiered process in which an initial estimate of stability class is obtained by identifying the stability class bin that the observed sigma theta value is contained and then modifying this initial estimate by considering time of day and observed wind speed. Nighttime is defined as one hour before sunset to one hour after sunrise. The remaining hours are daytime. Stability classes are categorized from 1 (Stability Class A, very unstable) through 6 (Stability Class F, very stable). In addition, all temperatures from the VCAPCD data set needed to be converted from degrees Celsius to degrees Kelvin in order to accommodate the data requirements of the OCD model.

6.1.3 Offshore Meteorological Data

In order to find the most relevant offshore data sets to use in the OCD model, several offshore monitoring stations were investigated to determine the quality of their data and appropriateness for use for this Project. The VCAPCD was contacted about the monitoring station located on Anacapa Island. This monitoring station provided data from August 1987 through December 1992. The data was sporadic, not pre-processed, and not available electronically. It also did not include all data parameters required by the OCD Model. The SBCAPCD was contacted concerning the monitoring stations located on Santa Rosa Island and Santa Cruz Island. The data from these locations only provided ozone air quality data. The CARB and the Navy (Point Mugu Geophysics Division) were contacted about the availability, nature, and quality of data from the monitoring station on San Nicholas Island. This data was not quality assured or quality controlled, and it did not include all parameters which are required by the OCD Model. Therefore, it was determined that data from offshore buoys was the most relevant for use in the OCD model.

The offshore meteorological data used for the Project was from the National Oceanic Atmospheric Administration (NOAA), Buoy Station 46025 - Santa Monica Basin – 33NM west southwest of Santa Monica, CA, for the years 1991-1993. This data set was most appropriate since it provided parameters necessary for input into the OCD model such as water temperature, over-water wind speed, and over-water wind direction. Data from this time period corresponds with the selected onshore data set. Analysis of the data showed at least a 90 percent recovery rate for all possible hours for each reporting year. A data substitution routine was performed for missing data, since the OCD model cannot be performed if there are any missing data gaps in the data set. There were limited instances where hourly data were missing for more than a few hours. For those instances, the following missing data substitution routine was employed. For the year 1991, two data gaps, one from February 5 to February 15 and one from March 8 to March 29, were replaced with 1993 data from the same time period. This data substitution routine was selected due to the similarities in the 1993 data to the 1991 data for these time periods. For the year 1993, a missing data gap from November 22 to December 23 was replaced with 1992 data from the same time period, also due to similarities in the data. For smaller, hourly data gaps, missing data was replaced with data from the preceding hour.

Buoy data, which is reported in Greenwich Mean Time (GMT), was converted from Pacific Daylight Savings Time (PDT) in order to be combined properly with the onshore data set. In addition, all temperatures from the buoy data set were converted from degrees Celsius to degrees Kelvin in order to accommodate the data requirements of the OCD model. These conversions were executed prior to performing the OCD model runs. A constant relative humidity of 80 percent was assumed for the over-water data analysis. The use of the default humidity percent value is identified in the OCD Model User's Guide (Version 5).

The over-water stability class determination was also performed for the offshore data. The stability classification system for over-water is strictly dependent upon the Monin-Obukhov length and does not apply additional wind speed or time of day cutpoints as used for overland stability. Stability class over water is a function of Monin-Obukhov length according to the following scheme (assuming typical over-water roughness lengths):

L (m.)
$-10 \leq L < 0$
$-25 \leq L < -10$
$[L] > 25$
$10 < L \leq 25$
$0 < L \leq 10$

The Monin-Obukhov length, in general terms, is the ratio of mechanical turbulence and buoyancy as expressed by the equation below:

L = -u*^3 x Tv / kg Qvo

where,
u* is friction velocity (portion of mechanical turbulence due to wind speed)
Tv is virtual temperature (equivalent temp. of dry air)
k and g are von Karmann and gravitational constants
Qvo is the kinematic virtual heat flux (i.e, indicator of buoyancy)

Therefore, if negative buoyancy is evident and the denominator is of the same order of magnitude as the numerator, an F stability will likely be estimated. Because constant relative humidity was assumed for every hour, the primary factors driving variations in hourly over-water stability for this application were wind speed and the temperature difference between the over-water air and water temperatures.

6.1.4 Quality Control

As mentioned above, the OCD model requires a combination of offshore meteorological data with onshore stability class and temperature data. This data was formatted into an OCD model input file as follows:

- Over-water Stability
- Over-land Stability
- Over-land Wind Direction
- Over-land Wind Speed meters/sec (m/s)
- Over-land Air Temperature (° K)
- Over-water Wind Direction
- Over-water Wind Speed meters/sec (m/s)
- Over-water Air Temperature (° K)
- Over-water Water Temperature (° K)

The following QA/QC checks were run on this final modeling input data:

- Confirmed dry bulb temperature conversion from Celsius to Kelvin from onshore and offshore data EXCEL workbooks to modeling input file.
- Confirmed time shift conversion of onshore and offshore data.
- Confirmed data consistency between EXCEL workbooks and modeling input file for wind speed, wind direction, and dry bulb temperature.
- Confirmed data substitution routines in the offshore data.
- Reviewed stability class determinations for consistency.

Finally, the OCD model was run with the following control options:

- Terrain adjustment;
- Stack tip downwash-switch off;
- Gradual Plume Rise-switch off;
- Buoyancy-induced dispersion;
- Overland met data;
- Land Source;
- Pollutant decay rate via chemical transformation;
- Overland anemometer height;
- Overland wind and terrain; and
- Overland surface roughness length.

Table 6.1-1 lists the release parameters for the Project emission sources, and Table 6.1-2 lists the modeled emission rates for the Project emission sources.

6.2 AIR QUALITY IMPACT ANALYSIS

Results of the atmospheric dispersion modeling are provided in Tables 6.1-3 and 6.1-4, where estimated criteria pollutant concentrations from project emissions are compared to the PSD increments and the NAAQS.

Table 6.1-3 presents estimated maximum impacts relative to PSD Significance Thresholds and Class II Increments. This table indicates that the potential impacts of the Project will be less than PSD Significant Threshold levels for all pollutants and all averaging times, with the exception of the annual NO_2 concentration threshold. However, the estimated annual NO_2 concentrations fall below the PSD Significance Threshold level within 0.2 miles of the FSRU location (more than 14 miles from the nearest shoreline receptor).

For the NAAQS analysis, the highest model-estimated pollutant concentrations at the nearest onshore receptors were added to representative onshore background pollutant concentrations to assess compliance with NAAQS. Background air quality data was collected from the various Ventura County air quality monitoring stations for NO_2, CO, SO_2, and PM_{10}. Table 6.1-4 presents the NAAQS analysis. In all cases, model-estimated concentrations were negligible (i.e. less than PSD Significant Thresholds). Furthermore, modeling results indicated that in no case would an individual NAAQS for any pollutant and averaging time be threatened or exceeded due to Project emissions.

Table 6.1-1 Modeling Release Parameters

Release Parameter	Units	Main Gens	Backup Gen	Vaporizers	Emerg. Pump	Emerg. Gen	Life Boat
Release Height	meters	33	33	35	25	25	1
Release Diameter	meters	1.41	1.00	4.47	0.25	0.66	0.08
Release Velocity	meters/sec	53.4	44.0	2.1	82.1	85.0	85.0
Release Temperature	degrees K	700	700	300	700	700	700

Table 6.1-2. Modeled Emission Rates

Pollutant	Units	Main Gens	Backup Gen	Vaporizers	Emerg. Pump	Emerg. Gen	Life Boat
Nitrogen Oxides (as NO_2)	g/sec	6.04E-01	1.80E-01	1.11E+00	3.52E-02	2.46E-01	1.66E-03
Carbon Monoxide (CO)	g/sec	8.06E-01	2.06E-02	8.45E-01	4.34E-02	3.04E-01	3.03E-04
Sulfur Dioxide (SO_2)	g/sec	1.80E-03	1.25E-04	3.75E-03	2.71E-05	1.90E-04	6.32E-07
Particulates (as PM_{10})	g/sec	1.81E-01	1.08E-02	1.14E-01	1.94E-03	1.36E-02	9.94E-05

Table 6.1-3. PSD Significant Threshold and Increment Analysis

Pollutant	Averaging Period	Maximum Modeled Impact (μg/m3)	Federal PSD Significance Threshold (μg/m3)	Federal PSD Class II Increment (μg/m3)	Maximum Impact Distance From Vessel	
					Distance (m)	Direction (Sector)
CO	1-hr	31.03	2,000	----	825	SSE
CO	8-hr	15.80	500	----	413	N
SO_2	1-hr	----	25	----	-----	-----
SO_2	3-hr	0.10	----	512	633	NNE
SO_2	24-hr	0.04	5	91	608	ENE
SO_2	Annual	0.01	1.0	20	728	E
PM_{10}	24-hr	1.15	5	30	707	E
PM_{10}	Annual	0.16	1.0	17	700	E
NO_2	1-hr	40.87	----	----	825	SSE
NO_2	Annual	1.58	1.0	25	707	E

Notes: μg/m^3 = microgram per cubic meter; PSD = Prevention of Significant Deterioration; m = meters

Table 6.1-4. NAAQS Analysis (Nearest Onshore Receptor)

Pollutant	Averaging Period	Maximum Modeled Impact (μg/m3)	Background Concentration (μg/m3)	Total Impact (μg/m3)	State Standard (μg/m3)	Federal Standard (μg/m3)
CO	1-hr	2.99	8,469	8,472	23,000	40,000
CO	8-hr	0.58	4,921	4,922	10,000	10,000
SO_2	1-hr	-----	58	58	655	-----
SO_2	3-hr	<0.01	-----	-----	-----	1,300
SO_2	24-hr	<0.01	31	31	105	365
SO_2	Annual	<0.01	10	10	-----	80
PM_{10}	24-hr	0.04	97	97	50	150
PM_{10}	Annual	<0.01	29	29	30	50
NO_2	1-hr	3.02	186	189	470	-----
NO_2	Annual	0.01	26	26	-----	100

Notes: μg/m^3 = microgram per cubic meter; NAAQS = National Ambient Air Quality Standard